Assessing the Viability of ^{49}Ti(p,x)^{47}Sc for Medical Applications: A Genetic Algorithm Approach

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Scandium-47 is a promising radionuclide for theranostic applications in nuclear medicine, offering potential for both diagnostic imaging and targeted radiotherapy. Among the possible production routes, the ^{49}Ti(p,x)^{47}Sc reaction has been largely unexplored. Accurate modeling of nuclear reaction cross-sections is required to optimize yields and purity, ensuring its feasibility for clinical use. In this study, we apply genetic algorithms (GA) to improve nuclear reaction modeling, demonstrating their effectiveness in refining theoretical predictions and optimizing production conditions.

The first measurement of the ^{49}Ti(p,x)^{47}Sc cross-section was recently published [1], enabling a quantitative assessment of this production route. In this work, we employ GA to optimize level density parameters within the TALYS nuclear reaction code. Our results show that GA-driven optimization leads to more reliable predictions of reaction cross-sections, production yields, and radionuclidic purity. Notably, we found that the default TALYS model significantly overestimates both ^{47}Sc and ^{48}Sc production cross-sections. Furthermore, after GA refinement, the calculated purity of ^{47}Sc is even lower than initially expected. These findings indicate that this reaction is not a viable route for clinical production, reinforcing the need to explore alternative pathways.

Beyond this specific case, our results highlight the broader potential of GA in nuclear modeling, providing an efficient and systematic approach to optimizing nuclear reaction cross-sections. This methodology offers a powerful tool for improving theoretical predictions and guiding the development of medical radionuclide production.

References

[1] G. Pupillo, L. De Dominicis, S. Cisternino, S. et al., *J. Radioanal. Nucl. Chem.* **333** (2024) 59795985.